ROLL STABILIZING RELEASE LINER

FIELD OF THE INVENTION

This invention relates to release liners for supporting adhesive tapes, more particularly, to release liners which provide significant roll stability to narrow rolls of adhesive tape and, even more particularly, to release liners which provide significant stability to narrow rolls of double-sided adhesive tape, where the tape has a heat activated adhesive side and a pressure sensitive adhesive side. This invention also relates to such release liners in combination with an adhesive tape.

BACKGROUND OF THE INVENTION

Adhesive tapes have been useful in a variety of industrial and automotive applications. Double sided adhesive tapes have been used to bond together a variety of substrates or surfaces and are particularly useful for industrial and automotive applications. Double-sided adhesive tapes having a heat activated adhesive (HAA) side and a pressure sensitive adhesive (PSA) side (e.g., in the form of a foam core with a heat activated adhesive on one side and a pressure sensitive adhesive on the other side) have been found useful in bonding together substrates of dissimilar materials. For example, such tapes have been used to attach a rubber-type substrate (e.g., thermoplastic and thermoset olefinic elastomeric materials) to a metal or a painted metal surface. In particular, such attachment tape has been used to attach rubber-type weatherstrip to the painted metal surface of a vehicle. In such an application, the PSA is bonded to the painted metal surface and the HAA is bonded to the rubber-type substrate. Polyethylene (PE) and polypropylene (PP) materials have been used for the HAA, and acrylic adhesives and tapes (e.g., in the form of a foam core and adhesive) have been used for the PSA. Acrylic adhesives generally have excellent adhesion to metal and painted metal surfaces but generally do not bond well to rubber type materials. Heat activated adhesives such as, for example, polypropylene and ethylene acrylic acid copolymer containing materials have been used for bonding an acrylic adhesive layer to rubber-type materials.

Such double-sided attachment tapes are typically manufactured in wide sheets, laminated onto a release liner of matching width to form a tape assembly, and then wound into a roll. Such liners include a release side which is bonded to the PSA side of the tape during the lamination step. The liner is chosen to have a release side that is bondable to yet readily removable from the PSA side of the tape. One such liner that has been used in the past has an outer layer of high density polyethylene (HDPE) with a thickness of about 0.5 mils (0.0127 mm), a center layer of medium density polyethylene (MDPE) with a thickness of about 3 mils (0.0762 mm), and a second outer layer of low density polyethylene (LDPE) with a thickness of about 0.5 mils (0.0127 mm). The resulting wide roll of the tape assembly is then converted or separated (e.g., by slitting) into a plurality of narrower rolls of the tape assembly having the same width or varying widths, depending on the intended use(s) of the tape. For example, tape widths of about 0.5 in. (1.27 cm) or less have been used to bond weatherstrip to automobile door frames. The liner is left intact while the HAA is laminated to the weatherstrip using heat and pressure. The liner is then removed and the resulting weatherstrip composite is bonded to the auto body frame using the PSA side of the tape.

One problem encountered in the past has been the instability of narrow rolls of such tape assemblies which are made with tape having a HAA side and a PSA side. Since the PSA side is protected by the release liner, and not exposed, it is the HAA side that contacts the release liner, not the PSA side, when the tape assembly is wound into a roll. The coils or layers forming these prior narrow rolls have tended to slip and slide relative to one another, causing the roll to telescope and come apart. As a result, the diameter of such unstable narrow rolls has had to be limited because larger diameter rolls come apart easier. In addition, even such unstable narrow rolls with smaller diameters have had to be handled with great care to prevent them from coming apart. Such handling measures have included mounting the slit side of the narrow roll onto a support wafer (e.g., made of a high density polyethylene). The support wafer is then carried like a plate to support and prevent coils of the narrow roll from telescoping apart. Thus, the use of narrow rolls of such tape assemblies has been cumbersome, time consuming and costly.

Therefore, there is a need for a release liner which provides more stability to narrow rolls of adhesive tape assemblies containing tape with a HAA side and a PSA side.

SUMMARY OF THE INVENTION

The present release liner provides more roll stability (i.e., the coils forming the roll are less likely to fall apart when the roll is held suspended along its outer circumferential edge) when used with double-sided tape having a heat activated adhesive ("HAA") side and a pressure sensitive adhesive ("PSA") side. In this way, the present invention satisfies the need for more stable rolls, especially more stable narrow rolls, of adhesive tape assemblies containing tape with a HAA side and a PSA side.

In one aspect of the present invention, an adhesive tape assembly is provided which comprises a double-sided adhesive tape and a release liner according to the teachings of the present invention. The tape includes a front adhesive side comprising a HAA layer of a heat activated adhesive and a back adhesive side comprising a PSA layer of a pressure sensitive adhesive. As used herein, "heat activated adhesive" refers to an adhesive that bonds to a contacting substrate or other surface when enough heat is added to the adhesive. The release liner includes a front liner side comprising a release layer in contact with, bonded to and readily removable from the PSA layer and a back liner side comprising a roll stability layer. The roll stability layer comprises an ethylene vinyl acetate and contacts the HAA layer when the adhesive tape assembly is formed into a roll. The roll stability layer is also operatively adapted to provide the adhesive tape assembly with a substantial increase in roll stability when formed into a roll of narrow width.

The HAA layer has a contact surface which contacts the roll stability layer when the adhesive tape assembly is formed into a roll. It is desirable for the contact surface to have a smooth, shiny or glossy finish. Surprisingly, such a smooth, shiny or glossy finish on the contact surface of the HAA layer appears to improve the coefficient of friction between the contacting surfaces of the HAA layer and the roll stability layer. Even so, the adhesive tape assembly may also exhibit improved stability with the contact surface of the HAA layer having a matte finish.

The release layer may comprise any material suitable for functioning as a release layer for a pressure sensitive adhesive and being bondable to the roll stability layer. Alternatively, the surface of the release layer, in contact with the PSA layer, may be coated with a release material such as, for example silicone or fluorocarbon. However, it may be

desirable to avoid the use of such release materials to avoid contamination by this material.

It is desirable for the roll stability layer to comprise an ethylene vinyl acetate ("EVA") that has a low enough vinyl acetate ("VA") content to prevent the roll stability layer from blocking with the HAA layer. It is also desirable for the ethylene vinyl acetate to have a high enough VA content to obtain a coefficient of friction between the roll stability layer and the HAA layer that maintains stability of a roll of the adhesive tape assembly.

It is desirable for the roll stability layer to comprise an ethylene vinyl acetate having a vinyl acetate content of less than about 28% by weight. It is also desirable for the ethylene vinyl acetate of the roll stability layer to have a vinyl acetate content in the range of greater than about 5% up to about 24% by weight. It is further desirable for the ethylene vinyl acetate of the roll stability layer to have a vinyl acetate content in the range of about 8% to about 20% by weight.

It may also be desirable for the roll stability layer to include an anti-blocking agent (e.g., diatomaceous earth, clay and talc) in sufficiently low amounts so as to not significantly affect the coefficient of friction of the roll stability layer, when measured against the HAA layer.

It is believed that roll stability for the adhesive tape assembly can occur when the roll stability layer has a coefficient of friction of at least about 0.55, when measured against the HAA layer. It is also believed that roll stability can occur when the roll stability layer has a coefficient of friction of greater than about 0.5, when measured against the HAA layer. It is further believed that roll stability can occur when the roll stability layer has a coefficient of friction greater than about 0.4, when measured against the HAA layer.

When the adhesive tape assembly has an overall thickness of about 0.052 inches (0.132 cm) and is wound into a roll, with the roll stability layer contacting the HAA layer, the roll exhibits roll stability (i.e., the coils forming the roll do not substantially telescope or fall apart when the roll is held suspended along its outer circumferential edge) even when the roll has a diameter that is at least about 20 times the width of the adhesive tape assembly. This is the minimum diameter to width ratio at which roll stability problems have been experienced with rolls of prior adhesive tape assemblies comprising a double-sided adhesive tape, with a HAA side and a PSA side, and a release liner releasably bonded to the PSA side.

In another aspect of the present invention, an adhesive tape assembly is provided which includes a double-sided adhesive tape and a release liner. The tape includes a front adhesive side comprising a HAA layer of a polyolefin heat activated adhesive and a back adhesive side comprising a PSA layer of a pressure sensitive adhesive. The release liner includes a front liner side and a back liner side. The front liner side comprises a release layer, which is in contact with, bonded to and readily removable from the PSA layer. The back liner side comprises a roll stability layer, which contacts the HAA layer when the adhesive tape assembly is formed into a roll. The roll stability layer has a contact surface which has a coefficient of friction, when measured against the HAA layer, which provides a substantial increase in roll stability (i.e., the coils forming the roll do not fall apart when the roll is held suspended along its outer edge) to a narrow width roll of the adhesive tape assembly

In a further aspect of the present invention, a release liner is provided for use with a double-sided adhesive tape having a front adhesive side comprising a heat activated adhesive layer and a back adhesive side comprising a pressure sensitive adhesive layer. The release liner includes a front liner side comprising a release layer having an exposed contact surface bondable to and readily removable from the pressure sensitive adhesive layer; and a back liner side comprising a roll stability layer. The roll stability layer comprises an ethylene vinyl acetate and is operatively adapted (e.g., formulated) to provide a substantial increase in stability to a narrow width roll of an adhesive tape assembly formed by releasably bonding the release layer to the pressure sensitive adhesive side of the double-sided adhesive tape and then winding the resulting adhesive tape assembly into a roll.

The objectives, features, and advantages of the present invention will become apparent upon consideration of the present specification and the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an enlarged cross-sectional view of a portion of one exemplary tape assembly according to the present invention;

FIG. 2 is a side plan view of a tape assembly of narrow width and wound into a roll, according to the present invention; and

FIG. 3 is an edge view of the tape assembly roll of FIG. 2.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Although the present invention is herein described in terms of specific embodiments, it will be readily apparent to those skilled in this art that various modifications, re-arrangements, and substitutions can be made without departing from the spirit of the invention. The scope of the present invention is thus only limited by the claims appended hereto.

Referring to FIG. **1**, a release liner **10** according to the present invention is made with at least two layers, a release layer **12** and a roll stability layer **14**. The layers **12** and **14** define a front liner side or surface **16** and a back liner side or surface **18** of the liner **10**, respectively. An adhesive tape assembly **20** can be made, according to the present invention, by releasably bonding the liner **10** to a double-sided adhesive tape **22**. The tape **22** includes a front adhesive side or surface **24** defined by a HAA layer **26** of a heat activated adhesive and a back adhesive side or surface **28** defined by a PSA layer **30** of a pressure sensitive adhesive. The release layer **12** is in contact with, bonded to and readily removable from the PSA layer **30**. The roll stability layer **14** comprises an ethylene vinyl acetate and contacts the HAA layer **26** when the adhesive tape assembly **20** is formed into a roll. The roll stability layer **14** is also operatively adapted (e.g., formulated), as disclosed herein, to provide the adhesive tape assembly **20** with a substantial increase in roll stability when formed (e.g., convolutedly wound) into a roll **32** of narrow width.

The release layer **12** may comprise any material suitable for functioning as the release layer **12** and being bondable to the roll stability layer **14**. It can be desirable for the release layer **12** to comprise a polyolefin such as, for example, a polyethylene, a polypropylene, a copolymer of a polyethylene and/or a polypropylene, or a blend of polyethylene and/or a polypropylene. Useful polyethylenes include high density polyethylene (HDPE), medium density polyethylene (MDPE), low density polyethylene (LDPE), linear low

density polyethylene (LLDPE), and ultra-low density polyethylene (ULDPE). Medium density polyethylenes have a typical density in the range from about 0.93 g/cc to about 0.94 g/cc; low density polyethylenes have a typical density in the range from about 0.90 g/cc to about 0.92 g/cc; and linear low and ultra low density polyethylenes have densities below about 0.90 g/cc. The polyethylenes can be made by any method including use of conventional catalysts as well as metallocene catalysts. Desirable polyethylenes for the release layer **12** include MDPE, LDPE, LLDPE, and ULDPE.

The release layer **12** may also comprise, for example, silicone, perfluoroether or any other material suitable for functioning as the release layer **12**. Alternatively, the surface of the release layer **12**, in contact with the PSA layer **30**, may be coated with a release material such as, for example silicone or fluorocarbon. As another alternative, the release layer **12** may be a coating of such a release material that is bonded to the roll stability layer **14**. However, it may be desirable to avoid the use of such release materials to avoid contamination by this material.

It is desirable for the roll stability layer **14** to comprise a copolymer of an ethylene vinyl acetate ("EVA") that has a low enough vinyl acetate ("VA") content (e.g., less than about 28% by weight) to prevent the roll stability layer **14** from blocking with the HAA layer **26**, when the tape assembly **20** is wound into a roll **32**. Blocking occurs when, for example, the two contacting surfaces **18** and **24**, respectively, of the liner **10** and the tape **22** adhere to one another with sufficient force to cause stretching, plastic deformation or tearing of the liner **10** and/or the tape **22** when the roll **32** is unwound. Blocking is also a concern when the liner **10** is separately wound into a roll. Therefore, it is also desirable for the VA content of the EVA to be low enough (e.g., less than about 28% by weight) to prevent the roll stability layer **14** from blocking with the release layer **12**, when the release liner **10** is separately wound into a roll. It is also desirable for the ethylene vinyl acetate to have a high enough VA content (e.g., greater than about 5% by weight) to obtain a coefficient of friction between the roll stability layer **14** and the HAA layer **26** that maintains stability of a roll **32** of the adhesive tape assembly **20**.

It is desirable for the roll stability layer **14** to comprise an ethylene vinyl acetate having a vinyl acetate content in the range of greater than about 5% to less than about 28% by weight. It is also desirable for the ethylene vinyl acetate of the roll stability layer **14** to have a vinyl acetate content in the range of greater than about 5% up to about 24% by weight. It is further desirable for the ethylene vinyl acetate of the roll stability layer **14** to have a vinyl acetate content in the range of about 8% to about 20% by weight. In addition, a VA content of about 12% by weight in the EVA of layer **14** has been found to prevent blocking between the layer **14** of EVA and a layer **12** of LDPE, without the need to use an anti-blocking agent, when the liner **10** is separately wound into a roll.

When the release layer **12** comprises a polyethylene ("PE"), the degree of blocking between a contacting PE layer **12** and EVA layer **14** of a rolled-up release liner **10** has been found to decrease as the density of the PE decreases. For example, it has been found desirable for a release layer **12** comprising a polyethylene to have a density of up to about 0.92 g/cc in order to be readily removable from the PSA layer **30** and to prevent blocking between the release layer **12** and the roll stability layer **14**.

If it is desirable for the roll stability layer **14** to include an anti-blocking agent (e.g., diatomaceous earth, clay and talc), it should be in sufficiently low amounts so as not to significantly affect the coefficient of friction of the roll stability layer **14**, when measured against the HAA layer **26**. The addition of an anti-blocking should enable lower levels of VA to be used in the EVA of the roll stability layer **14**. An anti-blocking agent may be added to the EVA of the roll stability layer **14** while layer **14** is being formed (e.g., by an extrusion process) to prevent blocking between the layer **14** and a release layer **12** of PE, when the release liner **10** is wound into a separate roll. Using an anti-blocking agent (i.e., diatomaceous earth in a polyethylene binder) made by Ampacet Corporation, Tarrytown, N.Y., under the product designation Ampacet 10063, in amounts up to about 5% by weight based on the amount of ethylene vinyl acetate, had little effect on the coefficient of friction between a roll stability layer **14** and a HAA layer **26**. This anti-blocking agent was fed, by separate feed stream, into the extruder processing the EVA material so that the extruder mixed the EVA and the anti-blocking agent together.

It can be desirable for the release liner **10** to include an optional intermediate support layer **34** disposed between the release layer **12** and the roll stability layer **14** to provide the release liner **10** with additional structural support. Such additional support can be desirable, for example, in order to facilitate separation of the liner **10** from the adhesive tape **22**. By making the liner **10** stiffer than the adhesive tape **22**, with the addition of a suitable intermediate layer **34**, it is usually easier to separate the liner **10** and the adhesive tape **22**. The intermediate layer **34** may be a substantially continuous film, e.g., an extruded or solvent coated film, or may be a web, e.g., a non-woven, knit, woven, or other web, that has one or more holes or perforations therein, such as that disclosed in U.S. Pat. No. 5,167,995, which is incorporated herein by reference in its entirety. Satisfactory results have been obtained with an intermediate layer **34** comprising a high density polyethylene ("HDPE"). High density polyethylenes have a typical density of about 0.96 g/cc.

The release liner **10** of the present invention can be formed by co-extruding the various layers (e.g., the release layer **12** and the stabilizing layer **14**) and laminating them together at the same time. Alternatively, the liner **10** can be formed by extruding one of the layers (e.g., the release layer **12**) onto the another layer (e.g., the stabilizing layer **14**). In either case conventional commercially available extruders and techniques well known in the art can be used. For example, conventional blown film extrusion equipment and techniques can be used to simultaneously co-extrude two or more layers (e.g., layers **12**, **14** and **34**). One extruder is used to extrude each layer material. The extruders force their corresponding layers through a common die. In this way, the various layers can be laminated together simultaneously as they are formed. In blown film extrusion, the laminated layers are extruded into the form of a tube. The tube is then collapsed, rolled flat and the edges trimmed to form two liners **10**. The two liners **10** are then separated and, typically, each is wound into a roll for subsequent lamination to a double sided adhesive tape **22** to form a tape assembly **20**. In the case where the release layer **12** is silicone or fluorocarbon, for example, the release layer **12** may be applied as a solvent based coating, a water based coating, or a 100% solids coating (i.e., the solids are in liquid form without a solvent) onto the stabilizing layer **14**.

It is desirable for the HAA layer **26** to comprise an olefinic material, such as a polyolefin heat activated adhesive. Satisfactory results have been obtained with a HAA layer **26** comprising a polyethylene. The HAA layer **26** may also comprise a polypropylene, a copolymer of a polyethylene

and/or a polypropylene, or a blend of polyethylene and/or a polypropylene. Satisfactory results have been obtained with a HAA layer **26** manufactured by Felix Schoeller Technology Papers, Inc. of Pulaski, N.Y. under the product designation M-906. The M-906 is a HAA layer **26** of ethylene-propylene polyallomer having a thickness of about 2.5 mils (0.064 mm). Satisfactory results have been obtained with a PSA layer **30** comprising an acrylic pressure sensitive adhesive. In particular, satisfactory results have been obtained with an acrylic PSA layer **30** which includes a foam core layer **36**. The foam core layer **36** is disposed between the HAA layer **24** and the PSA layer **30**.

The HAA layer **26** can be supplied on a paper release liner **10**, corona treated and subsequently bonded to the PSA layer **30** or the foam core layer **36**, depending on the tape construction desired. Alternatively, an intermediate primer layer can be used to improve the strength of the bond between the HAA layer **26** and the PSA layer **30** or the foam core layer **36**. It is also desirable for the heat activated adhesive to be readily bondable to a wide range of thermoset and thermoplastic olefinic elastomers such as, for example, SANTOPRENE (manufactured by Monsanto, St. Louis, Mo.), ethylene propylene diene monomer (EPDM), polypropylene, high density polyethylene and low density polyethylene.

Referring to Fig. **2**, the surface **24** of the HAA layer **26** contacts the surface **18** of the roll stability layer **14** when the adhesive tape assembly **20** is wound into a roll **32**. Typically, when the assembly **20** is wound into a roll **32**, the HAA layer **26** is left exposed. Unexpectedly, it has been found desirable for the contact surface **24** to have a smooth, shiny or glossy finish. Surprisingly, such a smooth, shiny or glossy finish on the contact surface **24** of the HAA layer **26** appears to improve the coefficient of friction between the contacting surfaces **24** and **18**, respectively, of the HAA layer **26** and the roll stability layer **14**. Even so, the adhesive tape assembly **20** may also exhibit improved stability with the contact surface **24** of the HAA layer **26** having a matte finish.

Satisfactory results have been obtained when the contact surface **24** of the HAA layer **26** of HAA (i.e., the M-906 described above) has a surface roughness (i.e., a degree of smoothness) ranging from about 8 microinches (0.0002 mm) to about 26 microinches (0.00066 mm), with an overall average surface roughness of about 13.5 microinches (0.000343 mm), as measured with a profilometer such as the POCKET SURF III® (manufactured by Federal Products Corporation of Providence, R.I. Each of the surface roughness measurements (i.e., 26, 15, 9, 11, 15, 14, 8 and 10 microinches) used to obtain the overall average surface roughness of about 13.5 microinches (0.000343 mm) was itself an average value taken over about a half inch (1.27 cm) area of the surface being measured. Therefore, it is believed that satisfactory results can be obtained with an overall average surface roughness of less than or greater than the 13.5 microinches (0.000343 mm) actually measured. It is also believed satisfactory for the contact surface **24** of the HAA layer **26** to have an overall average surface roughness of up to and including about 26 microinches (0.00066 mm).

The contact surface for the layer of HAA (i.e., the M-906 described above) used in the past had a matte not a smooth, shiny or glossy finish. A sample of a prior layer of HAA had a surface roughness ranging from about 33 microinches (0.00084 mm) to about 48 microinches (0.0012 mm), with an overall average surface roughness of about 39.2 microinches (0.000996 mm). Each of the surface roughness measurements (i.e., 38, 33, 42, 35, 43, 37, 48, 37, 39, 39 and 40 microinches) used to obtain the overall average surface roughness of about 39.2 microinches (0.000996 mm) was itself an average value taken over about a half inch (1.27 cm) area of the surface being measured. Therefore, it is believed that satisfactory results may be obtained with the surface **24** of the HAA layer **26** having an overall average surface roughness of less than about 33 microinches (0.00084 mm) and, possibly, even less than about 39.2 microinches (0.000996 mm).

One theory for why roll stability occurs with the HAA layer **26** having a smooth, shiny or glossy contact surface **24** is that the surface **24** is smooth enough and the contact surface **18** of the roll stability layer **14** is tacky enough so that, when the two contact surfaces **18** and **24** are pressed against each other (e.g., when the adhesive tape assembly **20** is formed into a narrow width roll **32**), the contact surface **18** of the roll stability layer **14** is able to wet-out onto the smooth contact surface **24** of the HAA layer **26**. This wetting-out results in a substantial elimination of air being trapped (i.e., results in a vacuum being formed) between the HAA layer **26** and the roll stability layer **14**, sort of like a suction-cup effect. Atmospheric pressure can then generate a normal force which tends to compress or hold together the contacting surfaces **24** and **18**, respectively, of the HAA layer **26** and the roll stability layer **14**. This atmospheric pressure induced normal force is of a magnitude that sufficiently increases the frictional forces between the contacting surfaces **18** and **24** to improve the stability of the narrow width roll **32**.

The test data disclosed in the Table below indicates that roll stability for the adhesive tape assembly **20** can occur when the roll stability layer **14** has a kinematic coefficient of friction of about 0.577, when measured against a HAA layer **26** (i.e., the M-906 described above). Even so, it is believed that lower coefficients of friction may also provide significant improvements in roll stability. It is believed that roll stability for the adhesive tape assembly **20** can occur when the roll stability layer **14** has a coefficient of friction of at least about 0.55, when measured against the HAA layer **26**. It is also believed that roll stability can occur when the roll stability layer **14** has a coefficient of friction of greater than about 0.5, when measured against the HAA layer **26**. Based on the tabulated friction test results associated with prior liner and matte finish HAA layer, it is further believed that roll stability can occur when the roll stability layer **14** has a coefficient of friction greater than about 0.4, when measured against the HAA layer **26**. The coefficients of friction tabulated below were obtained in accordance with the test procedures described herein.

TABLE

Test #	Surface #1	Surface #2	C.O.F.
1	EVA	S-HAA	0.726
2	EVA	M-HAA	0.577
3	HDPE	S-HAA	0.374
4	HDPE	M-HAA	0.335

EVA = Ethylene Vinyl Acetate
HDPE = High Density Polyethylene
S-HAA = Shiny HAA (M-906)
M-HAA = Matte Finish HAA (M-906)

Coefficient of Friction Test Procedures

The coefficient of friction between each of the heat activated adhesives (S-HAA and M-HAA) and each of the liner layers (EVA and HDPE) were determined according to ASTM D4518-91 with the following changes. An inclined plane test apparatus was used having dimensions of 45.7 cm by 20.3 cm. The test was conducted using a block weighing